CHAPTER 34
Pulmonary Embolism

KEY TEACHING POINTS

- In patients with suspected pulmonary embolism the principal role of bedside examination is to identify the patient's overall probability of disease.
- A few *individual* physical findings increase probability of pulmonary embolism—respiratory rate greater than 30/minute, unilateral calf swelling, and parasternal heave—but these findings are infrequent and the increase in probability is only modest.
- By using well-validated scores (e.g., Wells score, revised Geneva score), clinicians can combine risk factors and clinical findings to accurately distinguish patients with low, intermediate, or high probability of pulmonary embolism. This information, combined with quantitative D-dimer measurements, identifies which patients require definitive testing using computed tomography (or ventilation-perfusion lung scanning).

I. INTRODUCTION

The diagnosis of pulmonary embolism is a difficult one that has frustrated clinicians for more than a century. For example, in up to half of hospitalized patients who die of pulmonary embolism, the diagnosis is not even considered.[1,2] Nowadays, when pulmonary embolism is suspected, the principal role of bedside examination is to determine the patient's overall probability of disease (i.e., low, intermediate, or high probability). This information, in turn, often combined with quantitative D-dimer levels, is used to select which patients should undergo definitive diagnostic testing for thromboembolism by computed tomography (CT) angiography, compression venous ultrasonography, or ventilation-perfusion lung scanning.

II. THE FINDINGS

Patients with pulmonary embolism present with dyspnea (61% to 83% of patients), pleuritic chest pain (40% to 48% of patients), hemoptysis (5% to 22% of patients), or syncope (4% to 26% of patients).[3-10] Syncope is more common (affecting 20% to 80% of patients) when pulmonary embolism is *massive*, meaning that it obstructs more than half of the pulmonary circulation.[11-13] Ten percent to 35% of patients report a prior history of thromboembolism, and 33% to 42% report calf or thigh pain.[3,5-9]

In recent years, several investigators using multivariate analysis have identified combinations of bedside findings that best identify a patient's overall probability of pulmonary embolism. Two widely studied scores are the **Wells score** (Table 34.1)[14]

TABLE 34.1 Wells Score for Pulmonary Embolism

Characteristic	Points
RISK FACTORS	
Previous pulmonary embolism or deep venous thrombosis	1.5
Immobilization or surgery in the previous 4 weeks	1.5
Cancer	1
CLINICAL FINDINGS	
Hemoptysis	1
Heart rate >100/min	1.5
Clinical signs of deep venous thrombosis	3
OTHER	
Alternative diagnosis is less likely than pulmonary embolism	3

Interpretation of total score: 0-1 point, low probability; 2-6 points, moderate probability; 7 or more points, high probability.
Based upon reference 14.

TABLE 34.2 Revised Geneva Score for Pulmonary Embolism

Characteristic	Points
RISK FACTORS	
Age >65 years	1
Previous pulmonary embolism or deep venous thrombosis	3
Surgery (under general anesthesia) or fracture (of lower limbs) within 1 month	2
Cancer (active or considered cured <1 year)	2
CLINICAL FINDINGS	
Unilateral leg pain	3
Hemoptysis	2
Heart Rate	
75-94 beats/min	3
≥95 beats/min	5
Pain on palpation of lower-limb deep veins and unilateral edema	4

Interpretation of total score: 0-3 points, low probability; 4-10 points, moderate probability; ≥11 points, high probability.
Based upon reference 15.

and the **revised Geneva score** (Table 34.2).[15*] For each of these scores, the clinician simply adds the points corresponding to each of the independent predictors that are present. The total score determines overall probability, as defined in the footnotes to Tables 34.1 and 34.2. Both scores combine similar risk factors (prior thromboembolism, immobilization, surgery, and cancer) and clinical findings (hemoptysis, tachycardia, and signs of deep venous thrombosis) to arrive at overall clinical

*The original Geneva score[8] was later revised to remove the patient's arterial blood gas measurement, which is often unavailable.

probability, although the Wells score also considers whether or not an alternative diagnosis is less likely than pulmonary embolism.

III. CLINICAL SIGNIFICANCE

A. INDIVIDUAL FINDINGS

The studies included in EBM Box 34.1 enrolled almost 5000 patients with suspected pulmonary embolism referred to centers having considerable experience with venous thromboembolism. In these studies, only one of five patients suspected of pulmonary embolism actually had the diagnosis.

Very few individual findings help the clinician to distinguish patients with pulmonary embolism from those without it. The only individual symptoms *increasing* the probability of pulmonary embolism are *sudden* dyspnea (likelihood ratio [LR] = 2.4),[6,7] syncope (LR = 2),[4-6] and hemoptysis (LR = 1.9).[3-10†]

The individual physical findings that increase the probability of pulmonary embolism are unilateral calf pain or swelling (LR = 2.5; see EBM Box 34.1), left parasternal heave (LR = 2.4), respiratory rate of more than 30 breaths/minute (LR = 2), and systolic blood pressure 100 mm Hg or less (LR = 1.9). The presence of wheezes (LR = 0.4) and fever higher than 38°C (LR = 0.5) modestly decrease the probability of pulmonary embolism. The presence or absence of a pulse rate of more than 100/minute as an isolated finding is overall unhelpful (LR = 1.3), although in one study the finding of a pulse less than 90/minute decreased the probability of pulmonary embolism (LR = 0.3).[3]

Other individual findings are unhelpful. Chest wall tenderness is found in 11% to 17% of patients in pulmonary embolism and has a LR that is not significant, emphasizing that this sign is not diagnostic of costochondritis. The presence of hypoxemia, defined either as room air pO_2 less than 80 mm Hg or as increased alveolar-arterial gradient, is also diagnostically unhelpful (both LRs not significant).[3,8,9,30]

B. COMBINING FINDINGS TO DETERMINE CLINICAL PROBABILITY OF EMBOLISM

In contrast to the modest accuracy of individual findings, EBM Box 34.1 indicates that a determination of "high probability" by either the Wells score (LR = 7.5) or revised Geneva score (LR = 6.6) markedly increases the probability of pulmonary embolism, whereas a determination of "low probability" by either score decreases it (both LRs = 0.3).

Both scores emphasize that accurate assessment of a patient's probability combines both risk factors and clinical findings. The probability of embolism is high if the patient has typical signs (e.g., tachycardia, leg swelling) and risk factors (e.g., cancer, immobilization) and lacks an alternative diagnosis. The probability is low if the presentation is atypical, there are no risk factors, and there *is* a likely alternative diagnosis (e.g., angina, congestive heart failure). Many studies have shown that the probability of pulmonary embolism in patients presenting with both low clinical

† In these studies the following risk factors and symptoms were found just as frequently in patients with embolism as in those without it: female gender, older age, previous heart disease, previous lung disease, estrogen use, recent trauma, dyspnea, chest pain (pleuritic or nonpleuritic), and cough. A few individual risk factors have LRs between 1.3 and 1.9 and thus increase probability a small amount: cancer, recent immobilization, recent surgery, and prior venous thromboembolism.

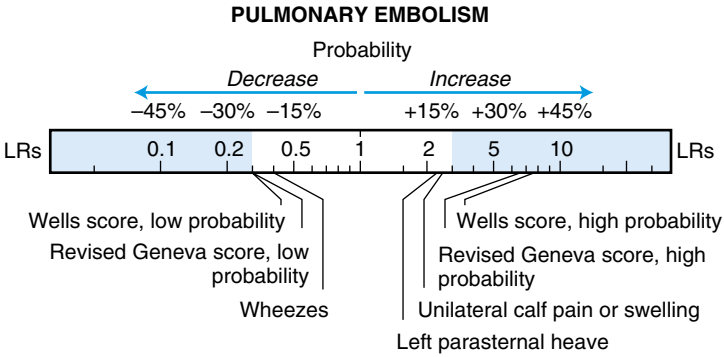
EBM BOX 34.1
*Pulmonary Embolism**

Finding (Reference)†	*Sensitivity (%)*	*Specificity (%)*	Likelihood Ratio‡ if Finding Is	
			Present	*Absent*
Individual Findings				
General Description				
Diaphoresis[9]	4	94	NS	NS
Cyanosis[4,9]	1-3	97-100	NS	NS
Vital signs				
Pulse >100/min[6-10,16]	6-43	66-96	1.3	NS
Systolic blood pressure ≤100 mm Hg[8]	8	95	1.9	NS
Temperature >38°C[4,6-9]	1-9	78-98	0.5	NS
Respiratory rate >30/min[8]	21	90	2.0	0.9
Lung				
Accessory muscle use[4]	17	89	NS	NS
Crackles[3,9,17]	21-59	45-82	NS	NS
Wheezes[6,9,17]	3-31	68-91	0.4	NS
Pleural friction rub[4,9]	1-14	91-99	NS	NS
Heart				
Elevated neck veins[4,9,17]	3-14	92-96	1.7	NS
Left parasternal heave[4,9]	1-5	98-99	2.4	NS
Loud P_2[3,9]	15-19	84-95	NS	NS
New gallop (S_3 or S_4)[3]	30	89	NS	NS
Other				
Chest wall tenderness[4,18]	11-17	79-80	NS	NS
Unilateral calf pain or swelling[5-7,9,10,17,19]	9-52	77-99	2.5	0.8
Combined Findings				
Wells Score[7,20-29]				
Low probability, 0-1 points	6-53	30-54	**0.3**	—
Moderate probability, 2-6 points	38-72	—	1.6	—
High probability, 7 or more points	7-54	90-100	**7.5**	—

EBM BOX 34.1
Pulmonary Embolism—cont'd*

Finding (Reference)†	*Sensitivity (%)*	*Specificity (%)*	Likelihood Ratio‡ if Finding Is	
			Present	*Absent*
Revised Geneva Score[15,24-27]				
Low probability, 0-3points	1-27	43-85	**0.3**	—
Moderate probability, 4-10 points	58-69	—	NS	—
High probability, ≥11 points	10-42	96-99	**6.6**	—

*Diagnostic standard: For *pulmonary embolism,* pulmonary angiography, CT angiography, or ventilation-perfusion scanning (± compression venous ultrasonography).
In eight studies,[15,18,20,21,23,25,27,28] some low-risk patients (i.e., those with negative quantitative D-dimers and low clinical risk) were not tested but instead were followed at least 3 months without anticoagulation; all lacked clinical evidence of thromboembolism.
†Definition of findings: for *Wells score* and *revised Geneva score,* see Tables 34.1 and 34.2.
‡Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.
NS, Not significant.
Click here to access calculator



probability (using either score) and normal D-dimer levels is so low that further imaging is unnecessary and anticoagulation can safely be withheld.[15,21,23,25,31,32]

The references for this chapter can be found on www.expertconsult.com.

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